THE EDGE MOOR CROSS DRUM BOILER

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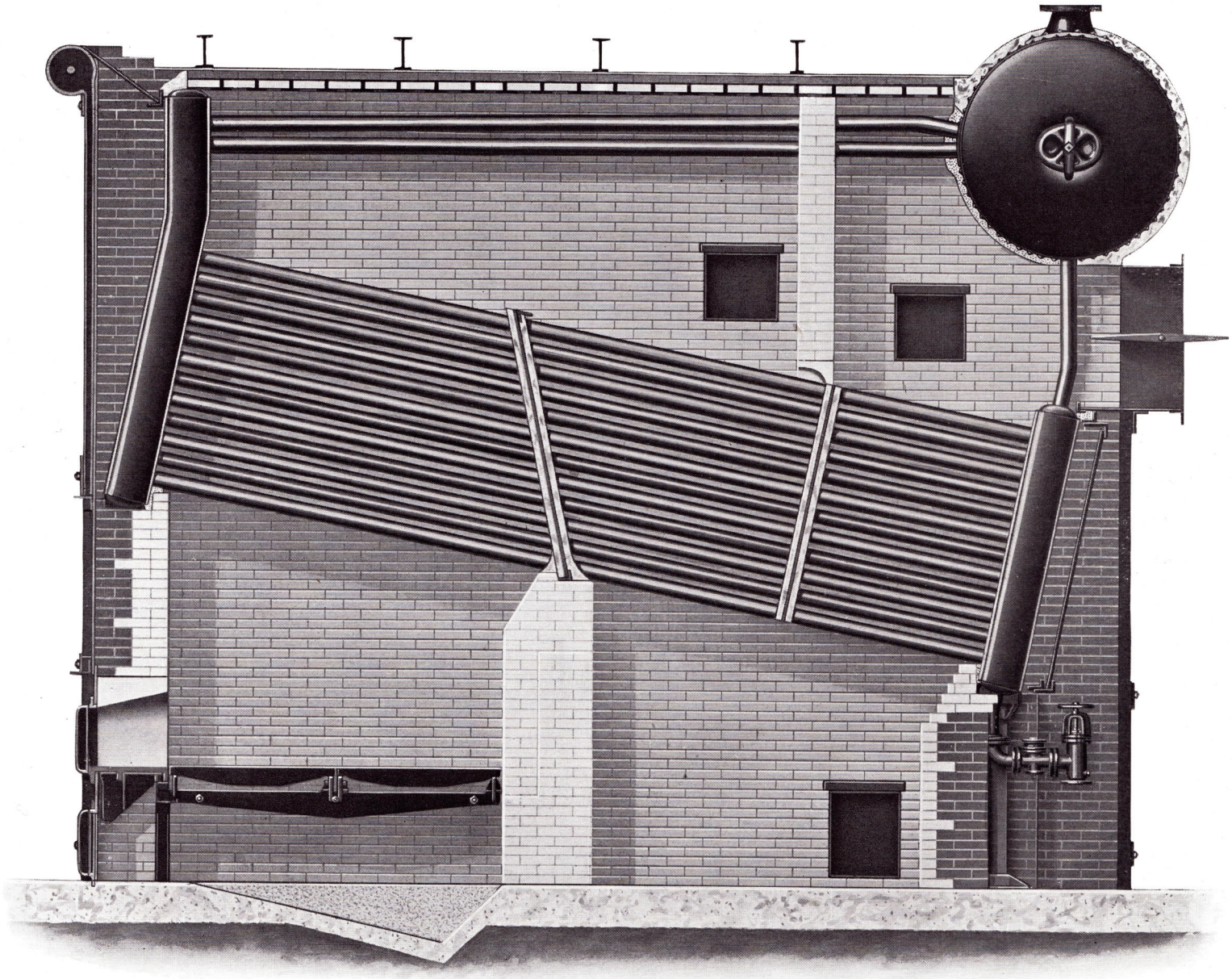
REGISTERED PROFESSIONAL ENGINEER
GEORGE W. O'NEILL
MECHANICAL
NOVA SCOTIA

CATALOG
NUMBER 65

EDGE MOOR IRON COMPANY
ESTABLISHED 1868
EDGE MOOR, DELAWARE



THE EDGE MOOR CROSS DRUM BOILER

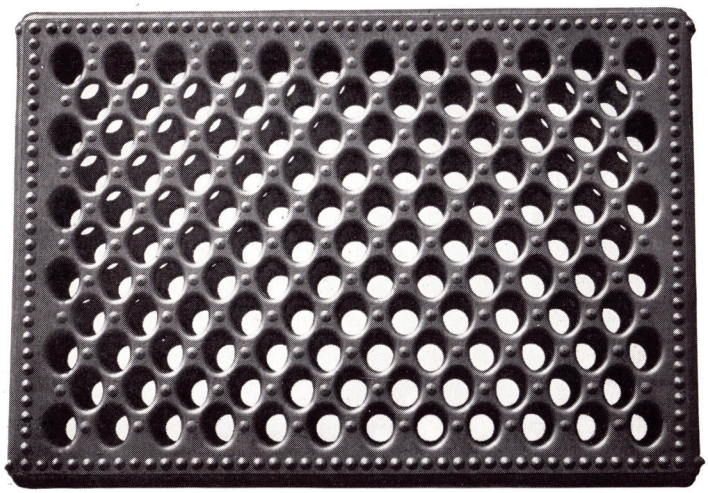
Description

The engraving on the opposite page shows a sectional view of an Edge Moor Cross Drum Boiler. A glance at its construction shows the boiler to be a container with the primary heating surface consisting of a series of tubes bringing as much water as possible into direct contact with the hot gases. As the water in the tube bank is converted into steam, both water and steam rise to the upper end of the tubes, are collected into the long header and delivered through the circulating tubes to the drum, from which the steam is drawn for use. Water in the drum, evenly distributed and sinking through the connecting nipples into the short header, takes the place of that driven out as steam.

The correctness of this fundamental principle of steam generation, common to all makes of horizontal water tube boilers, is an established fact. Years of use have proved the efficiency and easy maintenance of boilers of this type. But, while the basic theory remains the same, variations in design have been developed by different manufacturers with a view to increasing efficiency, giving greater structural strength, and promoting accessibility for care and maintenance.

The Edge Moor Cross Drum boiler is an all-steel boiler. Except for hand hole covers, which are in compression and are furnished in either steel or cast iron, no other metal than steel enters into the construction of the boiler proper. In a built-up boiler of this kind, all materials can be tested and quality accurately determined before use. Such tests are required for all material used in Edge Moor Boilers, and they are built to meet the specifications for the desired pressure of the A.S.M.E. code and the laws of the state or country in which they are to be installed.

The Headers

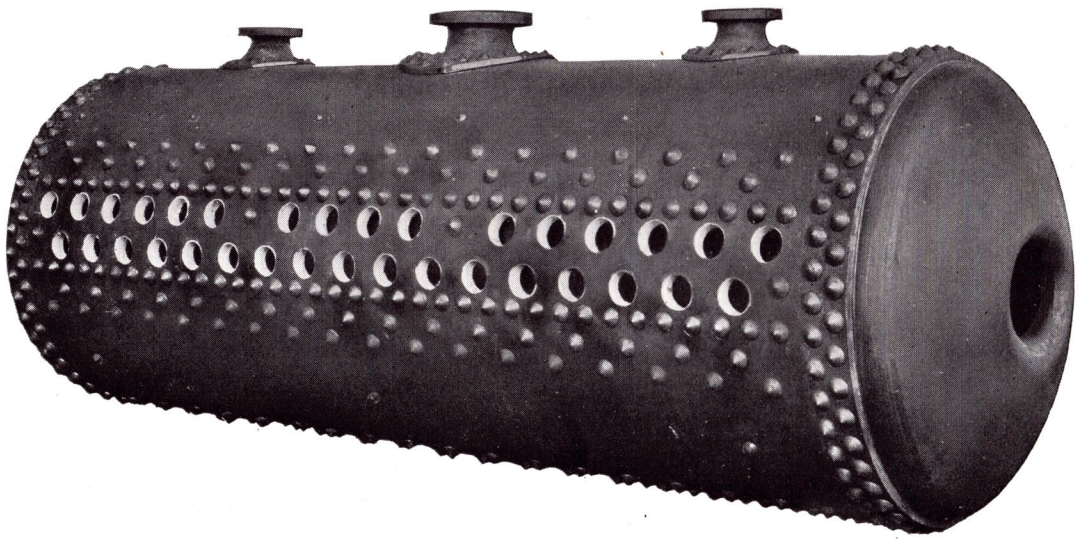


Box headers are formed by riveting the hand hole and tube plates to four rounded troughs, and these plates are firmly braced by regularly spaced stay bolts. Into the tube plate, which is in contact with the hot gases, straight tubes are expanded, and opposite each tube, openings in the hand hole plate give access to the tubes. When hand hole covers are tightened in place, both front and rear headers are converted into closed boxes.

The long header differs from the short header only in its extension at the top into the steam separating chamber carrying the circulating tubes. This chamber is set at an angle which will bring its plane at right angles to that of the circulating tubes.

The Drum

The drum is constructed of a plate rolled into a cylinder whose abutting edges are joined by butt straps riveted to the inside and outside of the cylinder.

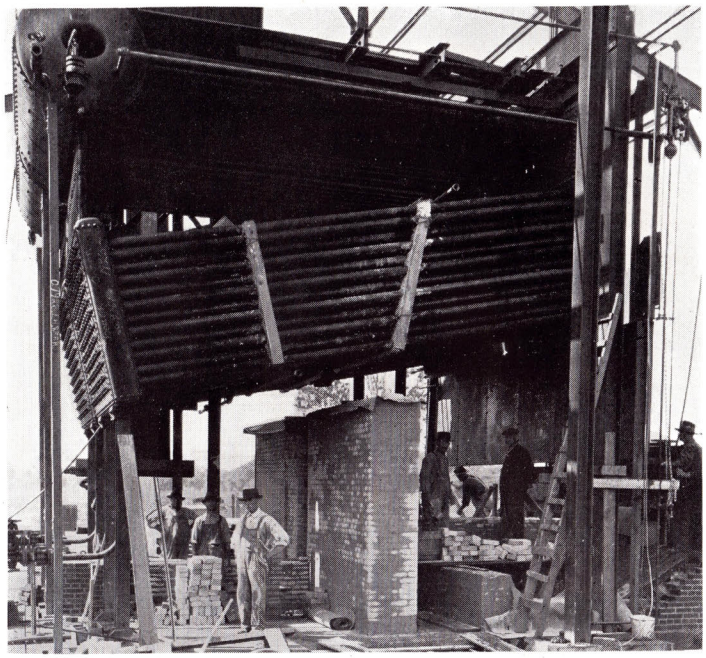


The ends of the cylinder are closed by dished heads, one of which carries a forged man hole for admission into the drum. Flanged connections riveted to the top of the drum provide for steam outlet and safety valves. Inside the drum are provided fixed baffles, around which the steam must pass at sharp angles to whip out the moisture before it leaves the boiler. A slotted trough, running the entire length of the drum, evenly distributes the feed water. A surface blow-down in the drum is furnished for the removal of scum.

The Tubes

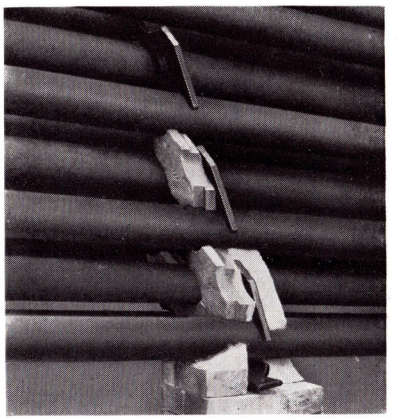
Unless otherwise specified, the tubes used in the Edge Moor Cross Drum Boiler are hot-rolled seamless steel. They are straight and of uniform diameter and are staggered in the tube bank in such a way as to break up effectively the stream of hot gases impinging against them. Two rows of circulating tubes connect the long header to the drum. In boilers designed for high ratings, three rows of circulating tubes are used.

The Baffles



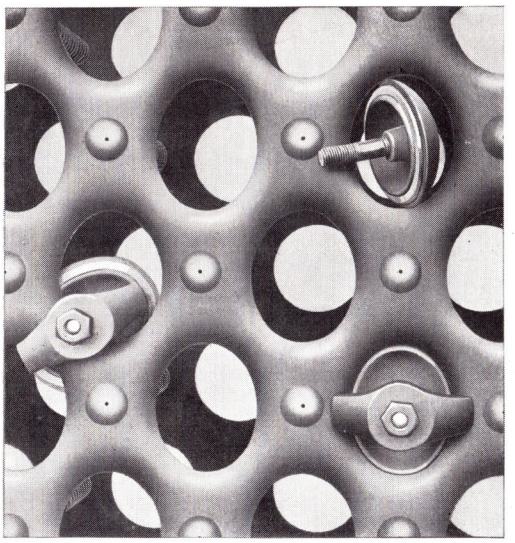
The spacing of the vertical baffles that direct the hot gases through the tube bank depends on the type of fuel used and the special operating conditions to be met. The ideal to be reached is that spacing which, allowing for the shrinkage in the cooling gases, keeps them moving constantly at the velocity at which the heat transfer is most efficiently accomplished. The baffles themselves are built up of cast iron plates,

fitting loosely between the tubes and bolted at top and bottom to cast iron cross pieces. Both sides of these plates are covered with a thick coating of high temperature plastic cement, hardening under the influence of heat. The front of the first baffle, in contact with the hottest gases, is faced with interlocking fire brick tile.

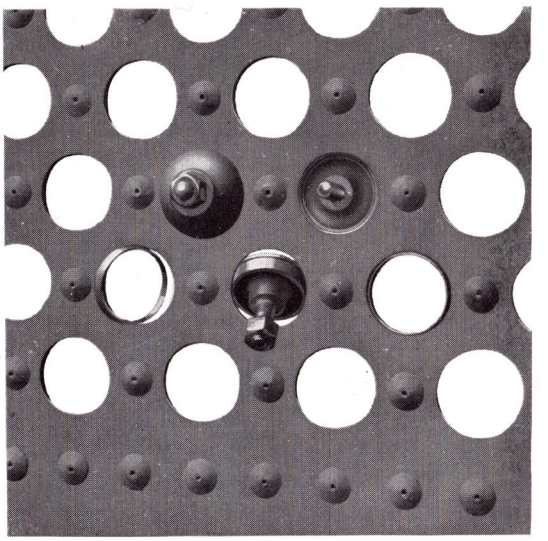


Hand Hole Covers

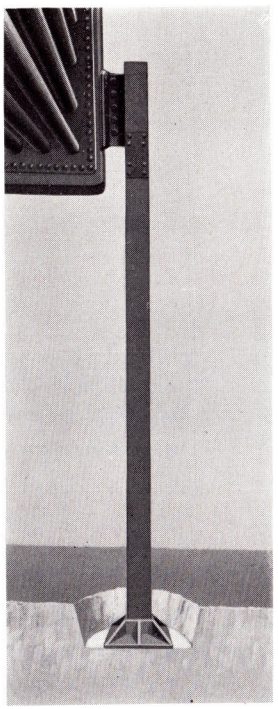
The hand holes are oval and the edges are forged inwards. Because of this elliptical shape, each cover can be passed through its own hole and tightened in place from the front. As the covers bear on the inside, increased pressure only holds them more securely.

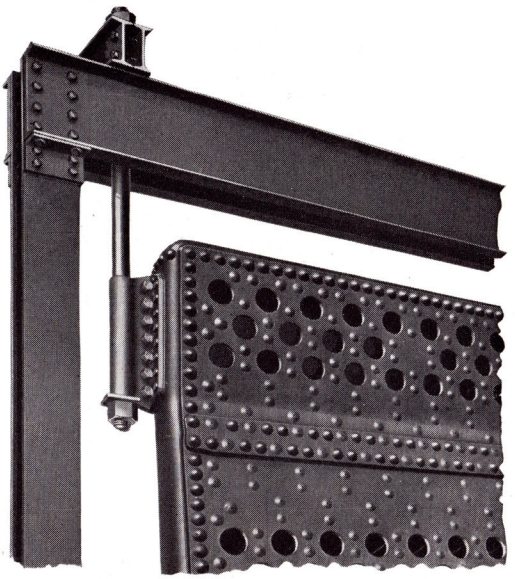


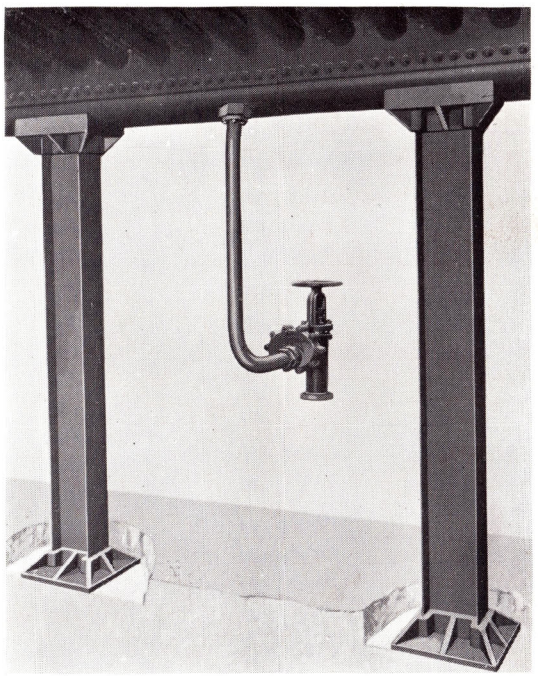
For pressures above 250 lbs., where thickness of metal makes forging impractical, the round hand hole covers, though larger than the holes themselves, can still be passed through these holes. Opposite sides of the covers are flattened, permitting them, when inserted at right angles, to be passed through to the inside of the plate. A soft steel ring, sprung through the hole, fits over the bearing surface of the cover, is used as a gasket, and makes an absolutely tight joint.



Supporting the Boiler







The Edge Moor Boiler is either supported on steel columns from below or hung from overhead beams. In either case, the boiler is supported independently of the brick work and is free to expand without affecting the setting.

When supported from below, the foot of the column is leaded into a cast iron base and the columns supporting the front header are bolted to tees riveted to the side troughs. For supporting the rear of the boiler, either of two methods may be used. Short columns are placed directly under the header and terminate in saddles in which the header rests, or, where practical, long columns extend to the under side of the drum and terminate in similar saddles.

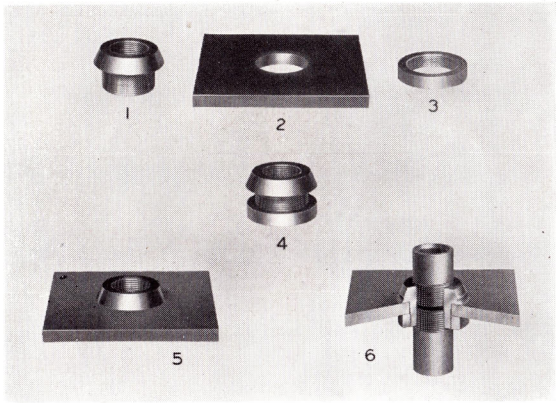
When the boiler is hung from above, a forged loop plate is bolted to tees riveted to the side troughs near the top of the front header and heavy steel rods passed through these loops. Steel straps passed around the drum support the rear.

Soot Blower and Cleaning Doors; Pipe Connectors

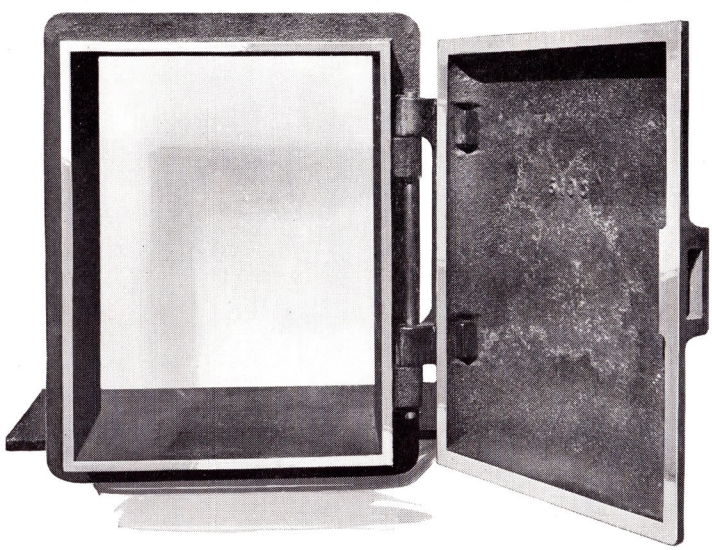
Care in design has also been given to the smaller details that go to make up the Edge Moor Boiler. Though apparently small in themselves, these details play an important part in keeping down operating and maintenance costs.

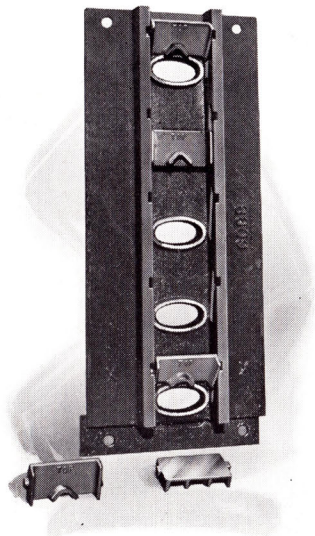
Thus, both soot blower and cleaning doors are machined and closely fitted. These operations, with the suitable locks with which the doors are equipped, reduce air leakage to a minimum.

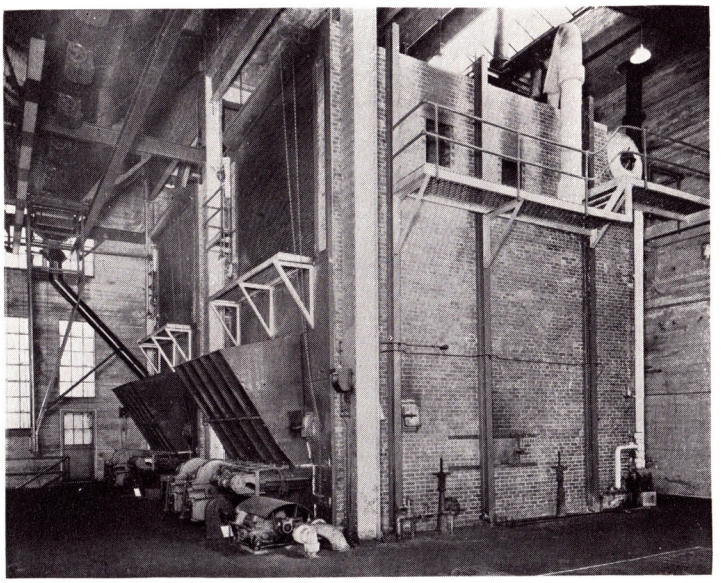
Wherever screwed connections are made for small openings, the Edge Moor Pipe Connector is used. This connector and its method of application are shown in the accompanying engraving.



Through the round hole 2 cut in the plate to be reenforced, the connector 1 is passed as at 5. The nut 3, threaded to an easy fit, is screwed by hand until it locks in place as at 6. Fullering and caulking the connector's beveled edge fit it so snugly and securely against the plate that it can be removed only by cutting the nut apart.





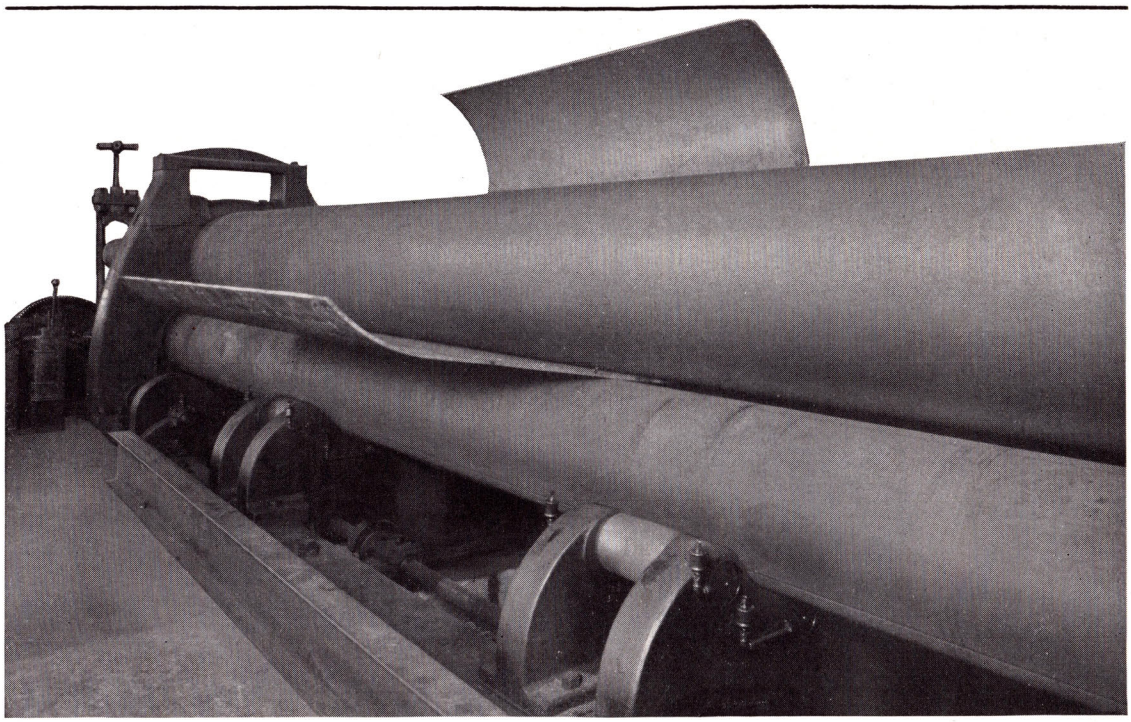


Buck Stays and Tie Rods

The boiler is encased in masonry work, lined throughout with fire brick, and the long side walls, subject to high temperatures, are strengthened against cracking by the incorporation into the brick work of tie rods, fastened at the ends of the boiler to steel angles. Buck stays, or steel beams, are fitted perpendicularly against the outside walls. By setting these beams in concrete and tying them together across the top, the brick setting is enclosed in a rigid frame work. The top of the boiler is covered with brick work supported on ventilated cross beams resting on the side walls and independent of the circulating tubes.

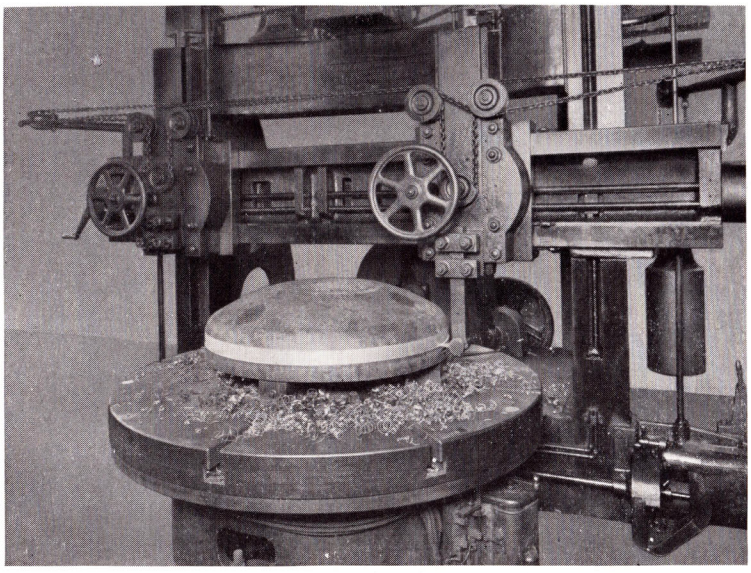
Edge Moor Shop Practices

While quality of workmanship can not compensate for incorrect design, the ultimate cost of power production may be materially affected and the benefits of efficient design offset by faulty construction. It is, therefore, essential to a thorough understanding of a boiler to consider the workmanship that backs up its design. The following pages give a pictorial description of the various steps of construction of the Edge Moor Cross Drum Boiler. The photographs have not been retouched except for elimination of backgrounds.



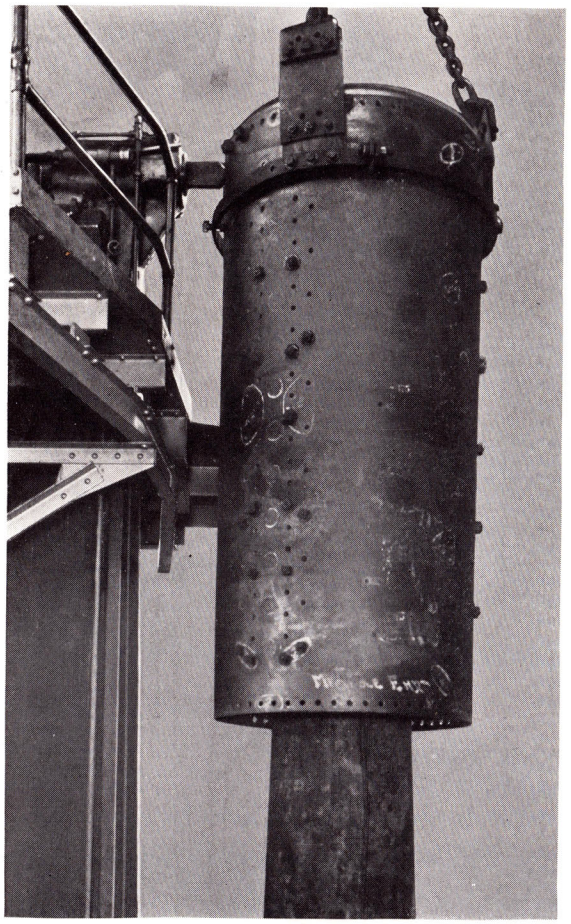
Rolling the Drum Plate

The formation of the drum plate into a cylinder is accomplished by three rolls arranged in pyramid form. The plate is inserted between the rolls and worked backward and forward, accompanied by a gradual lowering of the upper roll until the edges of the plate meet.



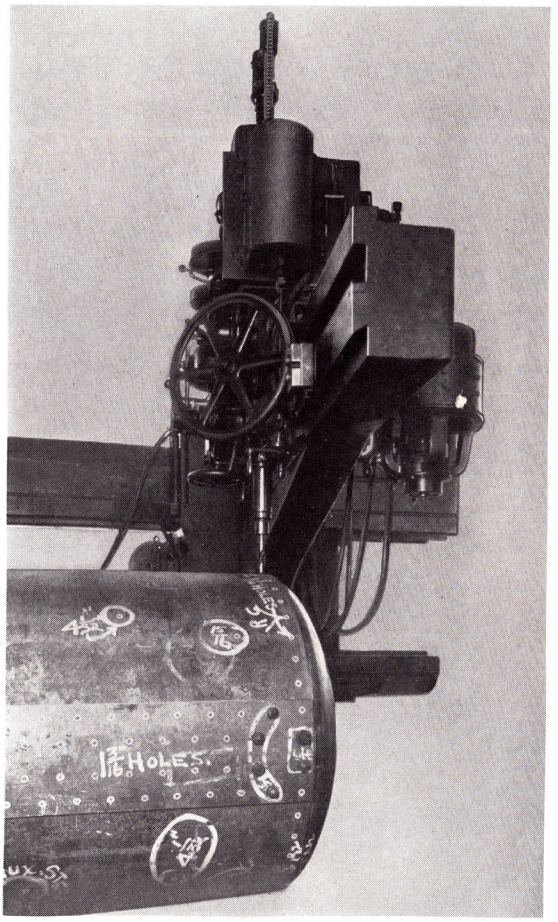
Planing the Drum Heads

Before assembling the heads into the drums, the entering edge is turned down, assuring a perfect fit.



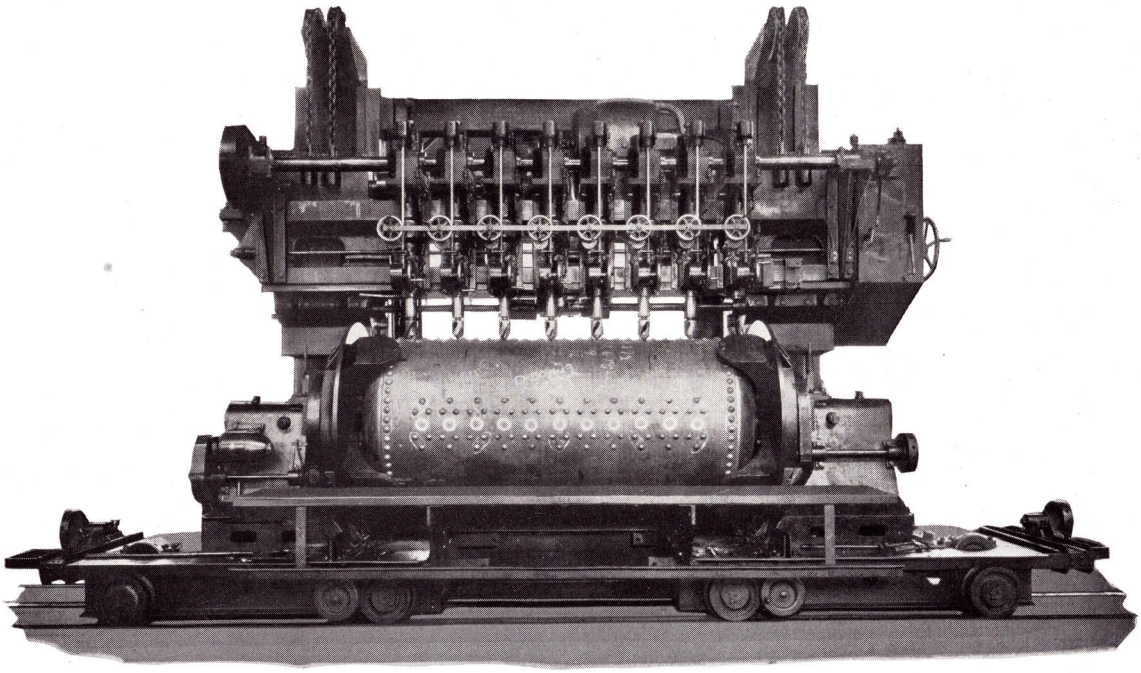
Driving Rivets

All rivets in the drum are set by the bull riveter, an hydraulically operated machine that drives the rivets home under tremendous pressure. In the engraving at the left, the drum is shown brought into position by suspending from an electric crane.



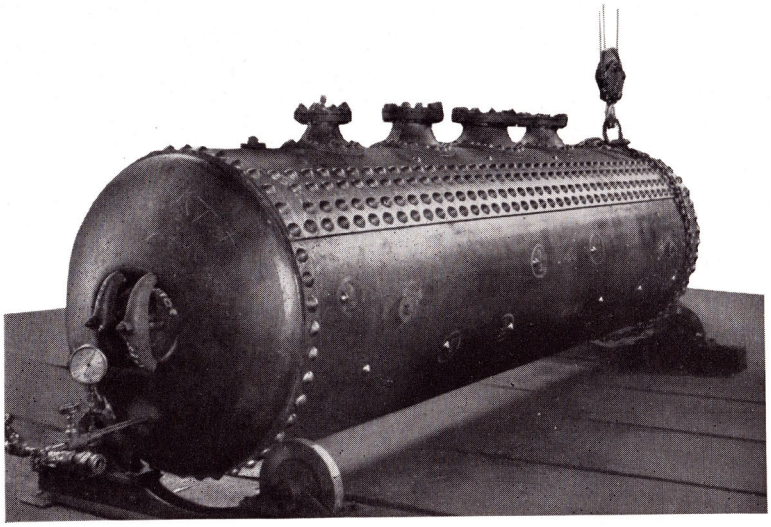
Drilling Rivet Holes

To secure alignment, all rivet holes are drilled with overlapping parts temporarily assembled by bolting through tack holes. When the drum has been dissembled and cleaned of burs and chips, a tight metal-to-metal joint is obtained.



Drilling Tube Holes

Tube holes in the drum are drilled by the multiple spindle drill shown above. Beneath the drill is a movable carriage, into the jaws of which the drum is mounted and held by set screws. The carriage is then moved and the jaws revolved until a series of holes is brought in position beneath the drills.



Testing

Before leaving the shop, the drum is subjected to water pressure fifty percent in excess of working specifications, and passed on by shop and insurance inspectors.

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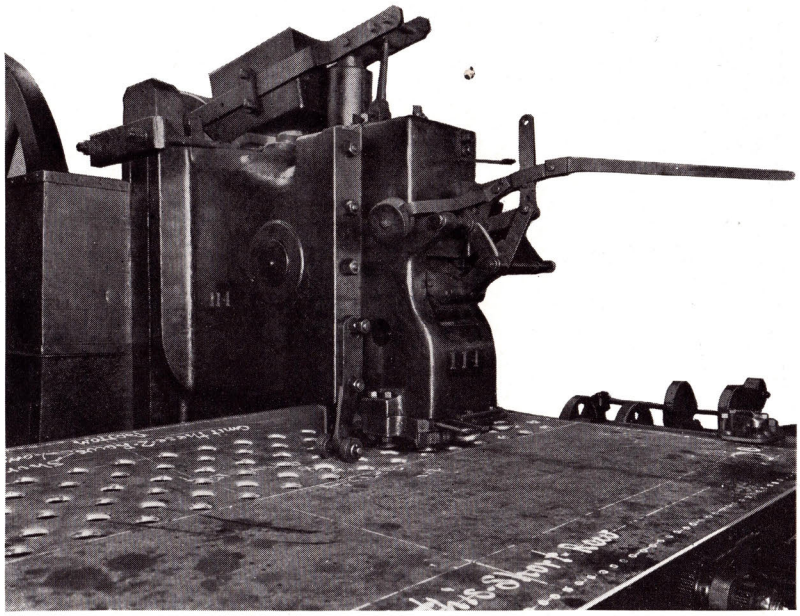
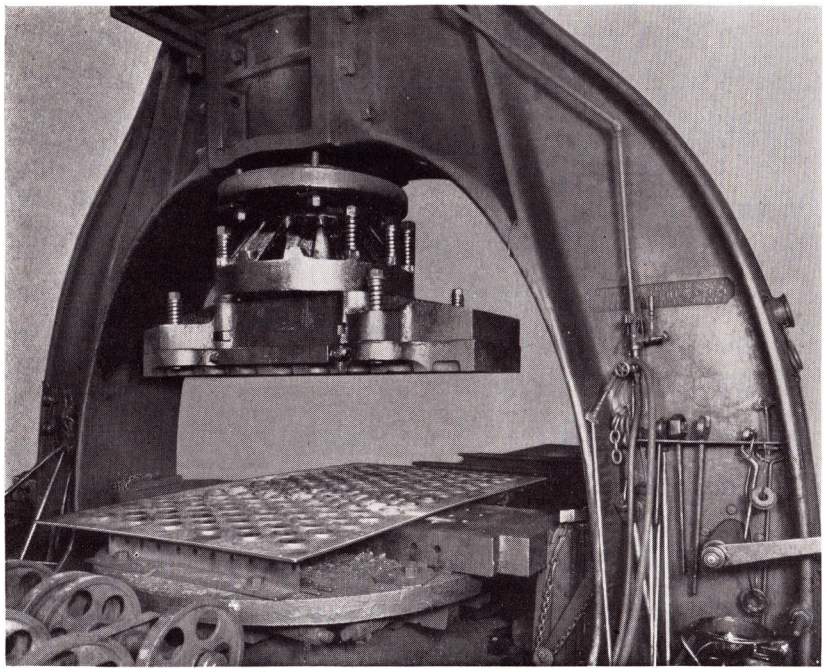
Stamping the Tube Holes

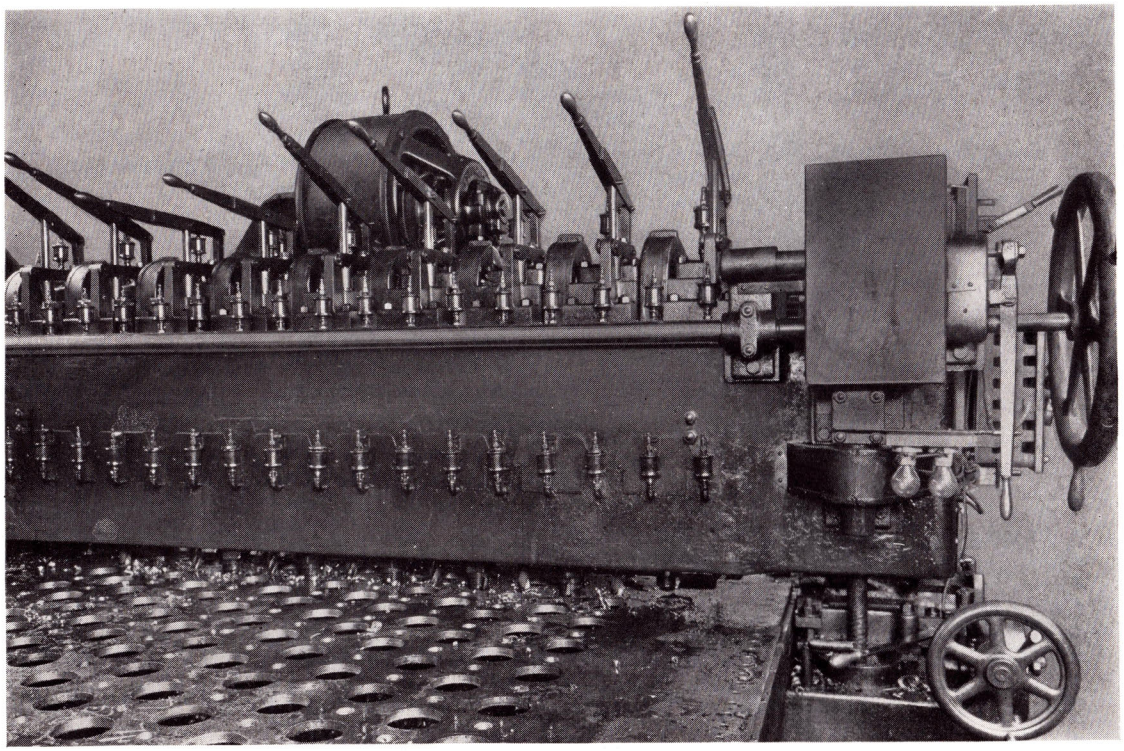


Tube and hand hole plates are stamped out by the same machine. In the case of hand hole plates for pressures below 250 lbs., elliptical instead of round dies are used. The plates are mounted on a spacing table, notched so as to halt the plates when moved the exact distance between tube holes. By this method, all holes are punched with one setting up of the plate.

Forging the Hand Hole Plate



A bearing surface is given the covers and strength added to the plate by an inward forging of the edges of the holes. The plate, heated to a cherry red, is forged under the steam hammer shown at left.



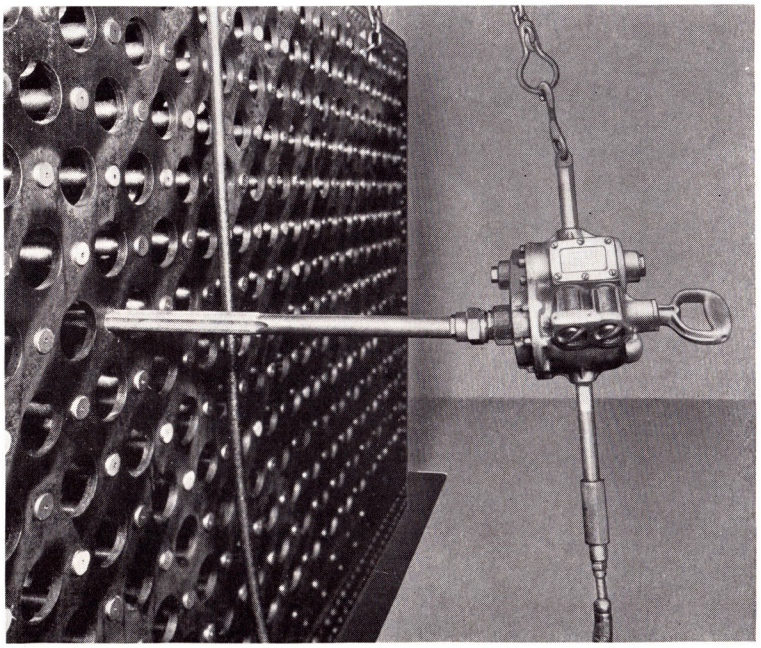
Drilling Stay Bolt Holes

A simultaneous operation drills the stay bolt holes and reams out the tube holes. The plate is mounted in the spacing table beneath the multiple spindle drill, an entire row drilled, the table advanced a notch to the next row, and the operation repeated until all tube and stay bolt holes are completed. In the case of the hand hole plate, the reaming tools are replaced by facers and stay bolt holes are drilled and hand holes faced by the same machine. All corresponding holes in both hand hole plate and tube plate are accurately aligned by this method of drilling.

Assembling the Header

As with the drum, rivet holes in the header are drilled with overlapping parts temporarily assembled and the hand hole plate is riveted to the troughs by the bull machine. Because of the header's box-like shape, the bull machine cannot be used on all plates, and rivets in the tube plate are driven with a pneumatic hammer, held on until they are black.

Tapping Stay Bolt Holes



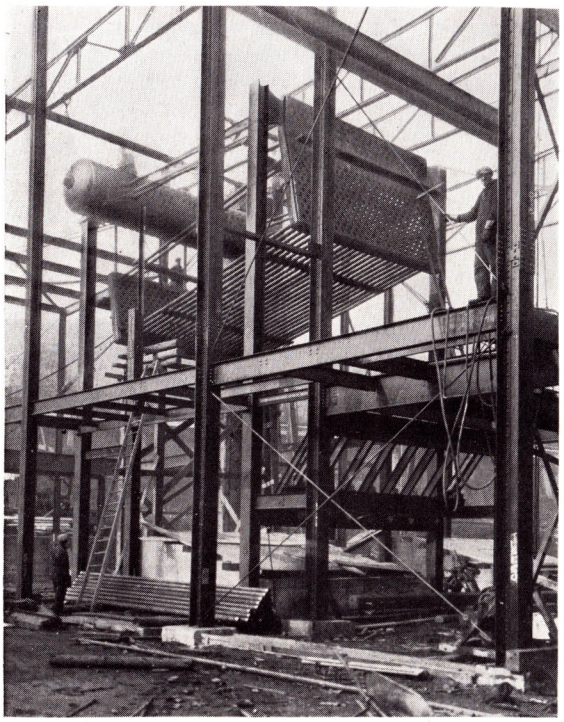
The stay bolts are threaded their entire length. By using a long tap which threads holes in both tube and hand hole plates as though in one piece of metal, the stay bolts may be screwed in place without chance of misalignment of threads. When in place, the protruding ends of the stay bolts are mushroomed over, jamming them tightly into the threads and preventing their loosening.

Caulking and Testing

As with the drum, the header is, before leaving the shop, caulked and subjected to water pressure fifty per cent in excess of working specifications.

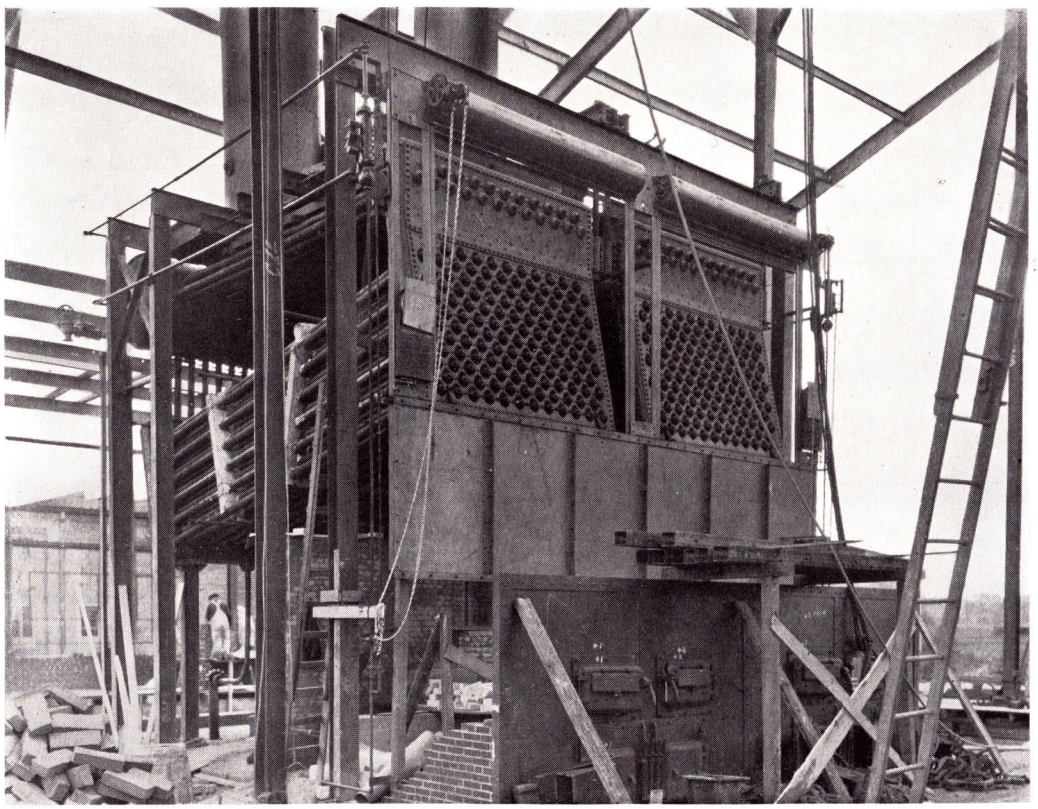
Rolling the Tubes

While a field process, rolling the tubes is an essential part of boiler construction. The end of the tube, polished to clean metal, is inserted in the hole and a tapered roller revolved in the entering end, forcing the tube securely against the wall of the hole. Another roller, set at a sharper angle, then flares the protruding ends. In this way, the tube bank, the circulating tubes, and the connecting nipples are expanded in place.



Erection of the Boiler

Under the direction of an Edge Moor superintendent, the headers are set up, correctly spaced, and held by rolling in them a few of the top and a few of the bottom row of tubes. Above the short header, a cribbing is built to hold the cross drum until installation of the circulating tubes and connecting nipples permanently secures it. Thus assembled, the boiler is jacked up and fastened to its permanent supports. The remaining tubes are then rolled in place, all fittings attached, and the completed boiler is subjected to water pressure at fifty per cent in excess of specifications.



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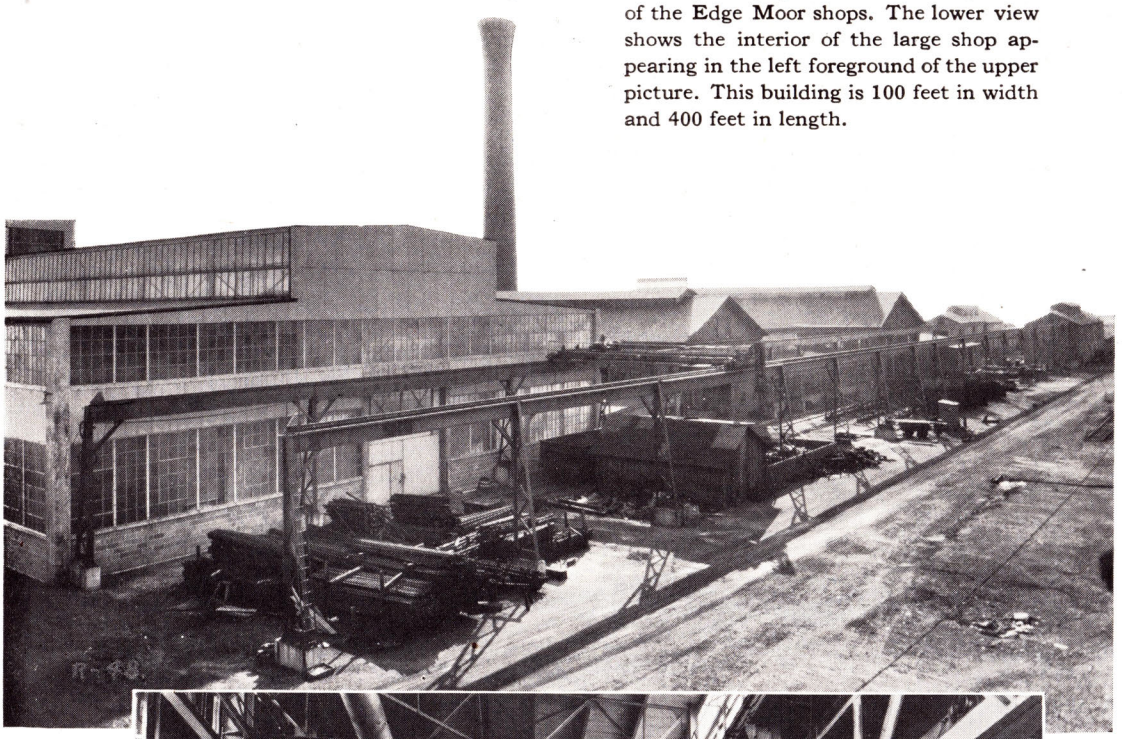
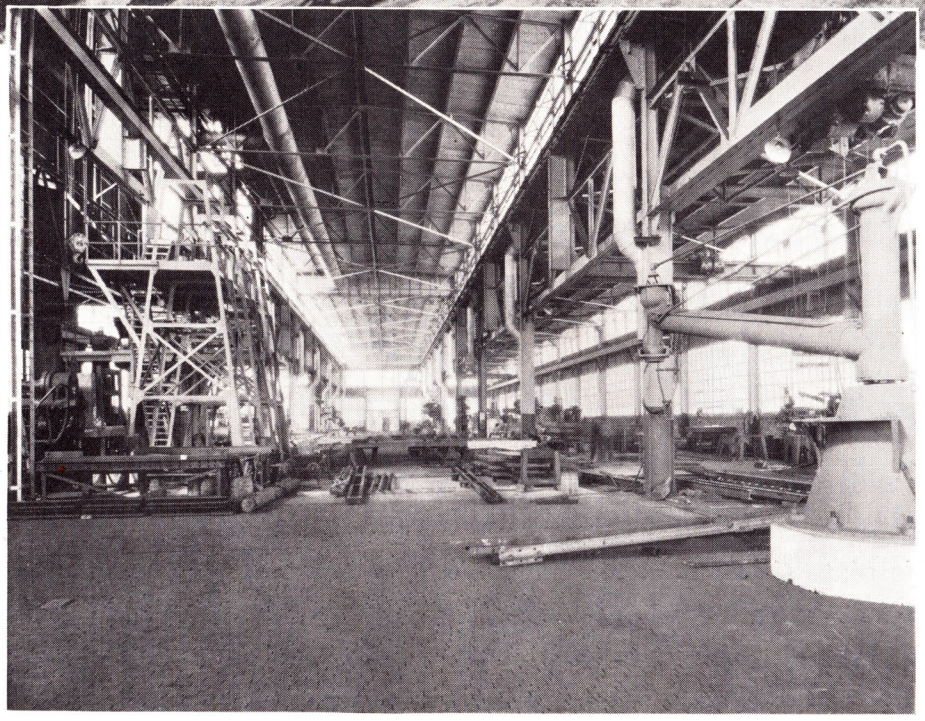
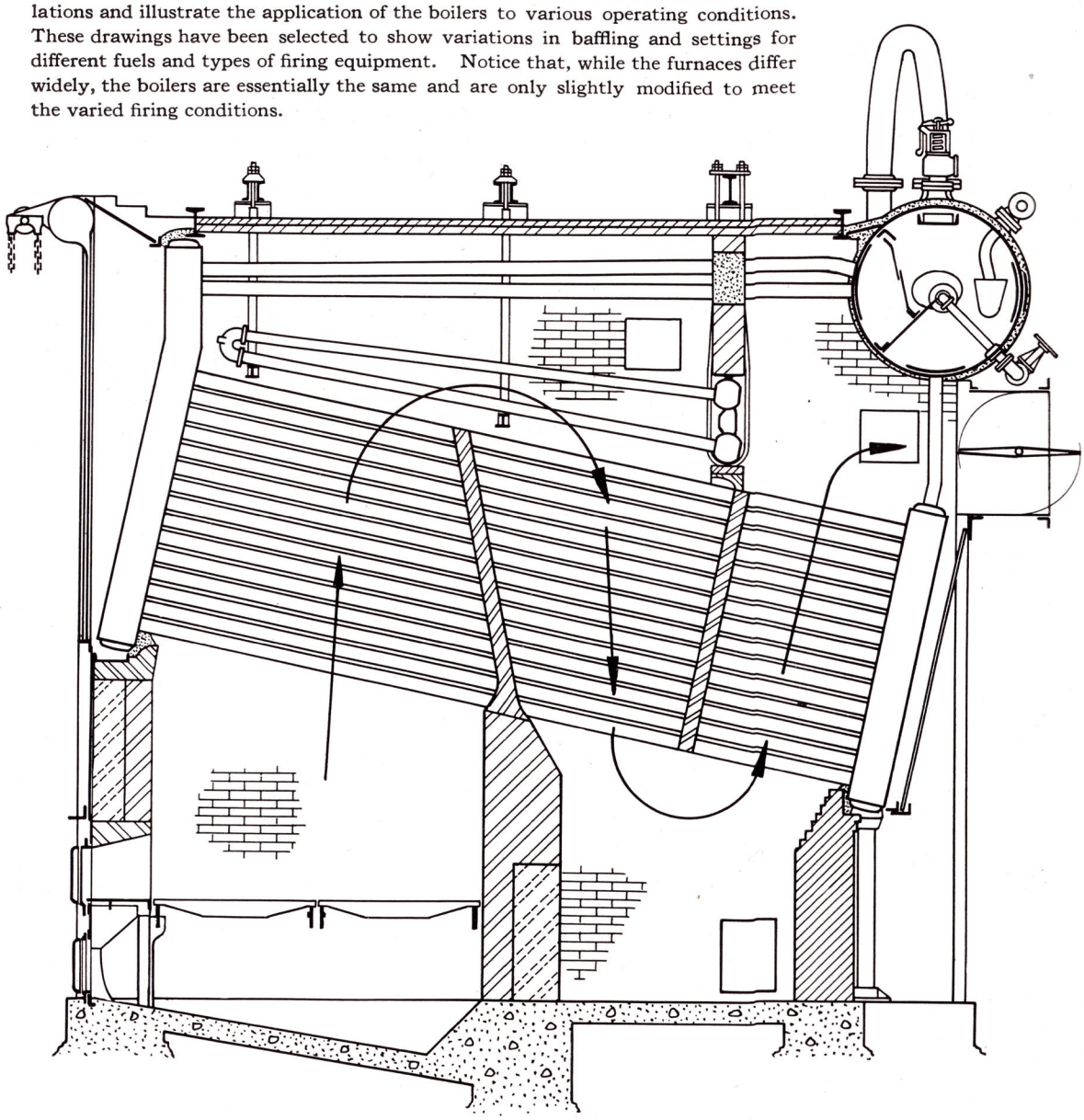
The photographs below show a portion of the Edge Moor shops. The lower view shows the interior of the large shop appearing in the left foreground of the upper picture. This building is 100 feet in width and 400 feet in length.





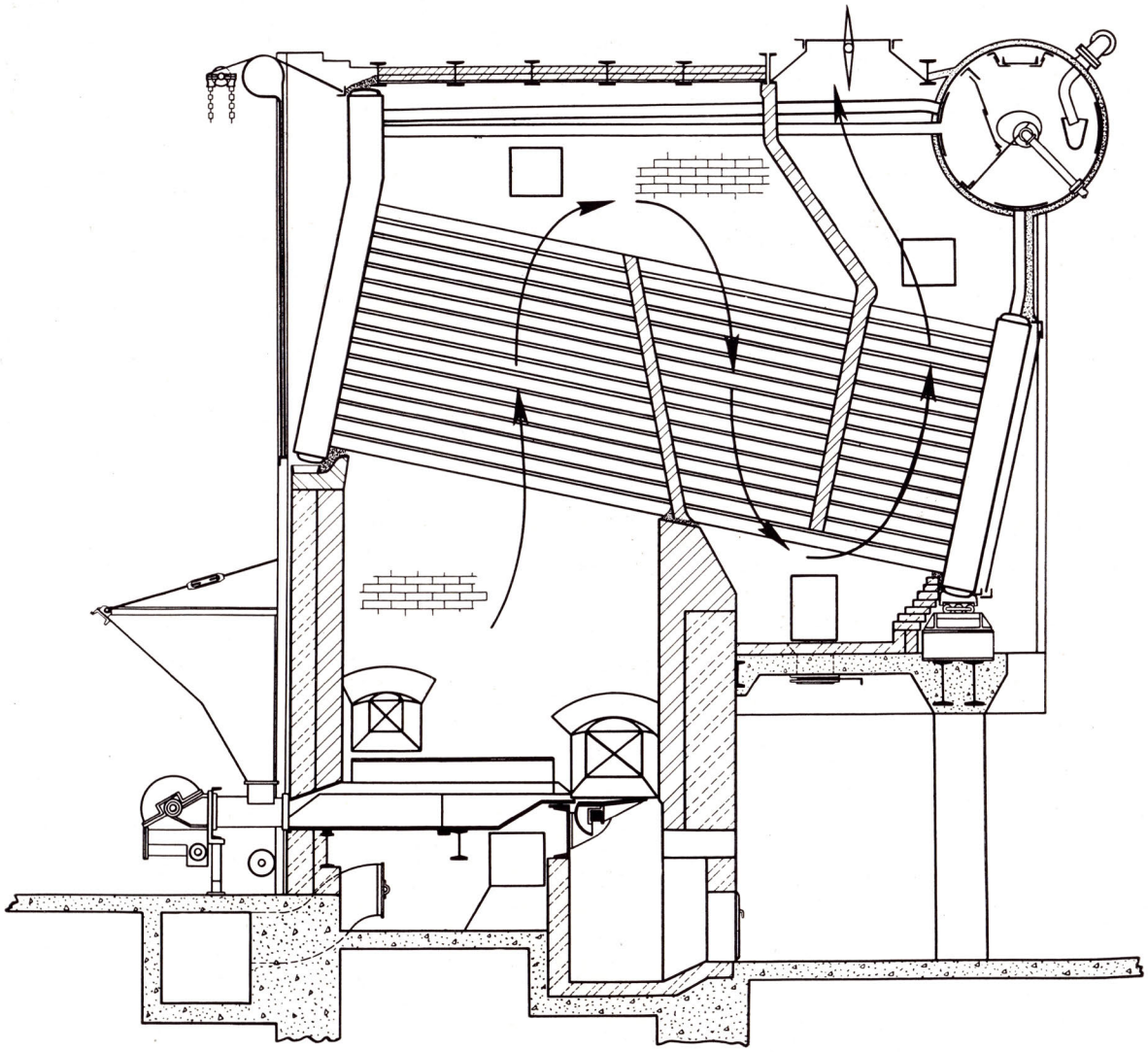
EDGE MOOR *Water Tube* BOILERS

The following line drawings are of actual Edge Moor Cross Drum boiler installations and illustrate the application of the boilers to various operating conditions. These drawings have been selected to show variations in baffling and settings for different fuels and types of firing equipment. Notice that, while the furnaces differ widely, the boilers are essentially the same and are only slightly modified to meet the varied firing conditions.



Hand-Fired Cross Drum Boiler

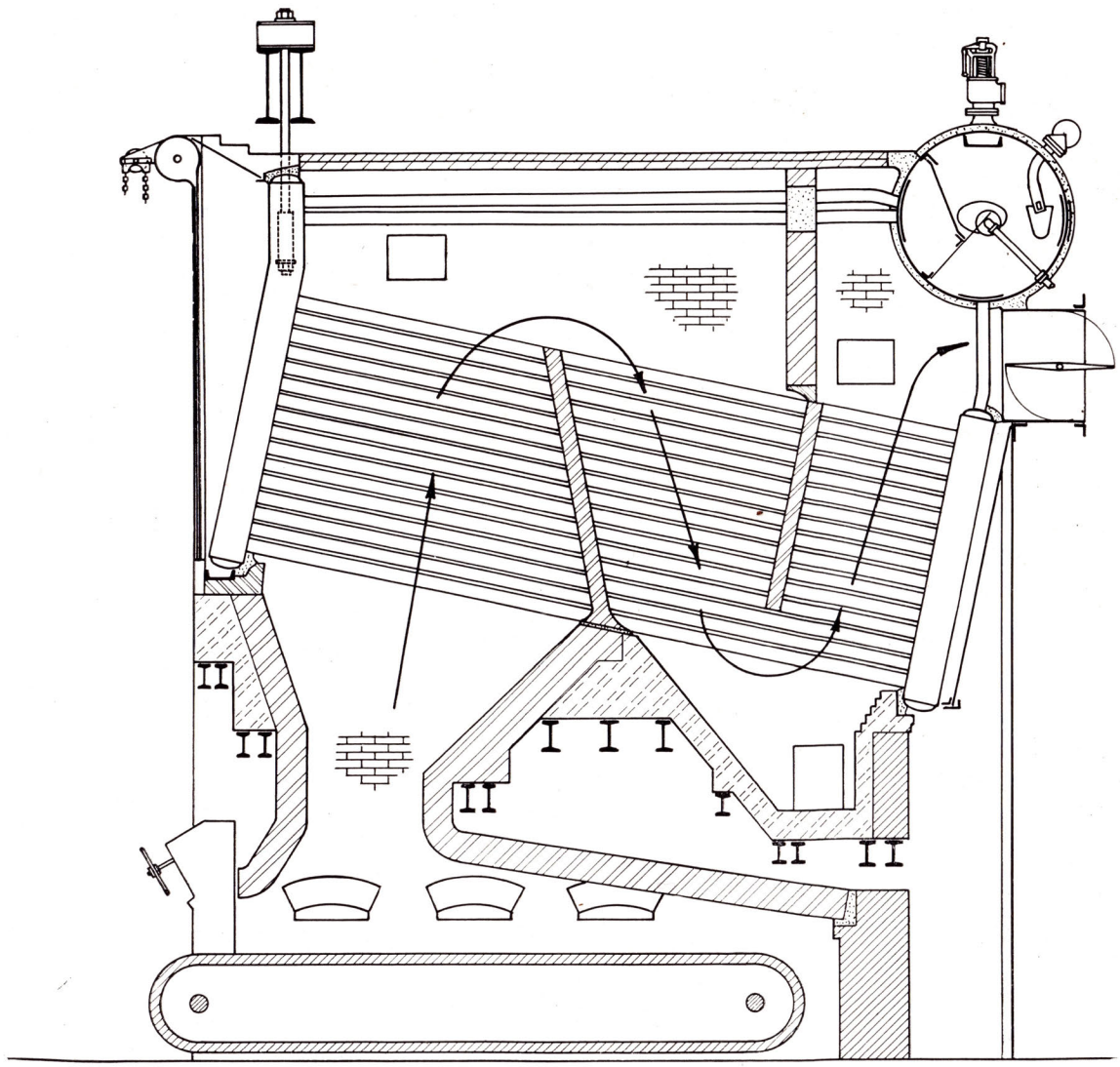
This plate shows a hand-fired cross drum boiler with baffles so arranged as to pass the gases three times across the tube bank and exhaust them through the rear of the setting between drum and header. Above the tube bank and below the circulating tubes is a simple convection superheater.



Cross Drum Boiler With Horizontal Underfeed Stoker

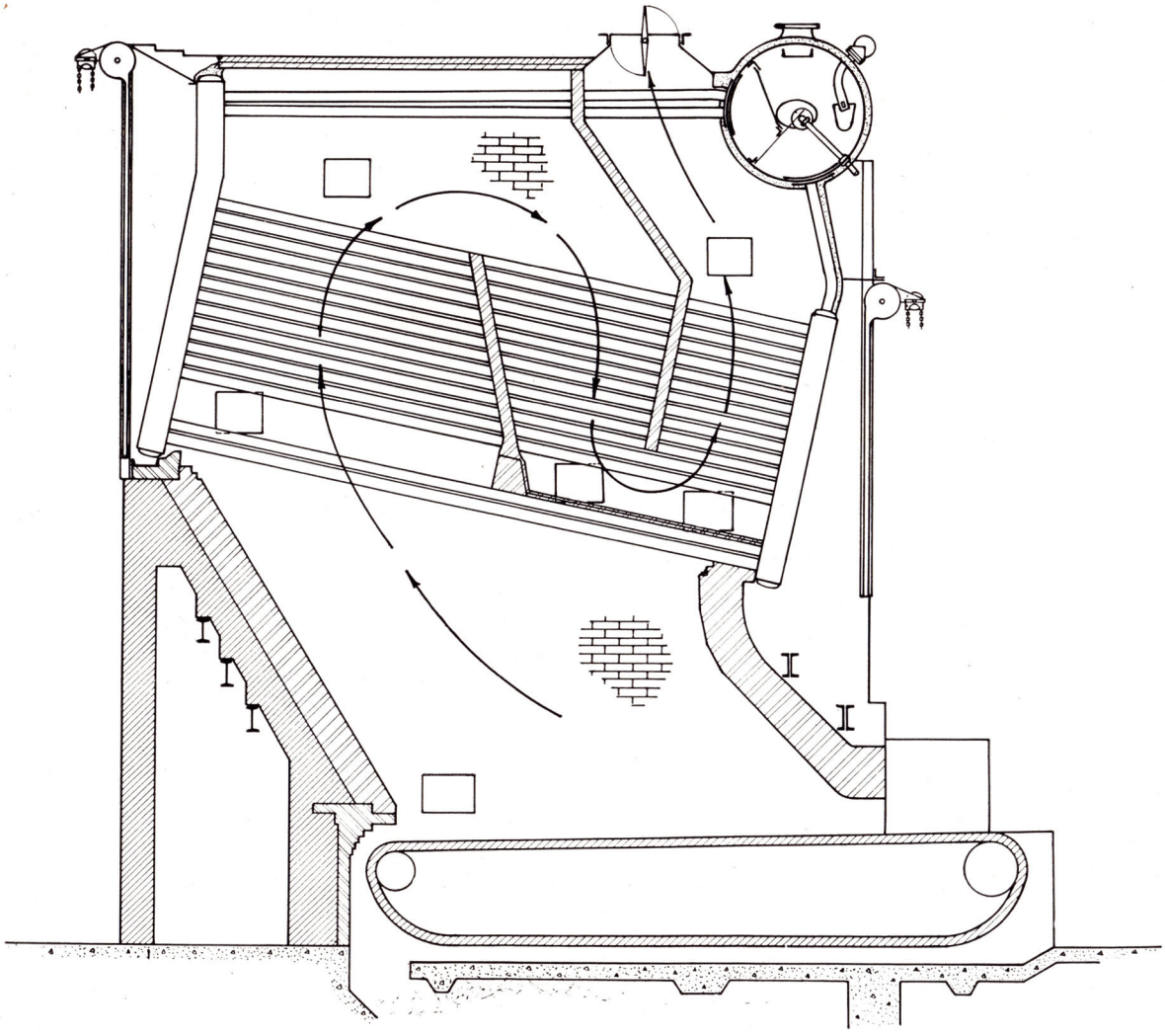
In this cross drum boiler setting, equipped with a rear dump underfeed stoker, the bridge wall is moved back to allow for complete combustion at higher rates of evaporation. The undercutting back of the bridge wall gives access to the rear of the furnace and the stoker for the removal of ashes. The baffling in this installation is similar to that in the preceding.

EDGE MOOR *Water Tube* BOILERS



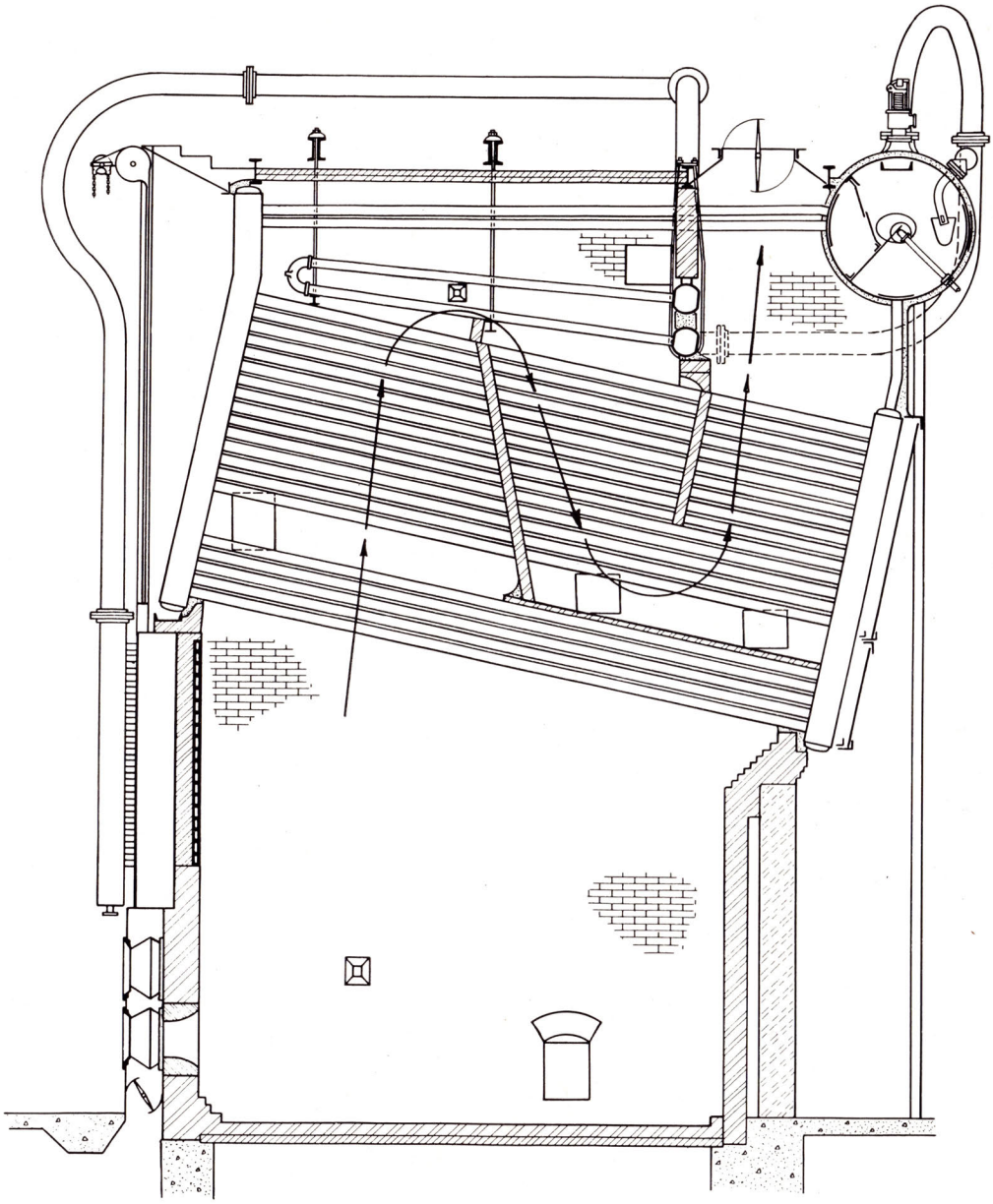
Boiler with Chain Grate Stoker for Anthracite Coal

In this installation, equipped with a forced draft chain grate stoker for burning anthracite coal, combustion is assisted by the special arches built over the grate and reflecting the heat back on the fuel bed.



Boiler with Chain Grate Stoker for Bituminous Coal

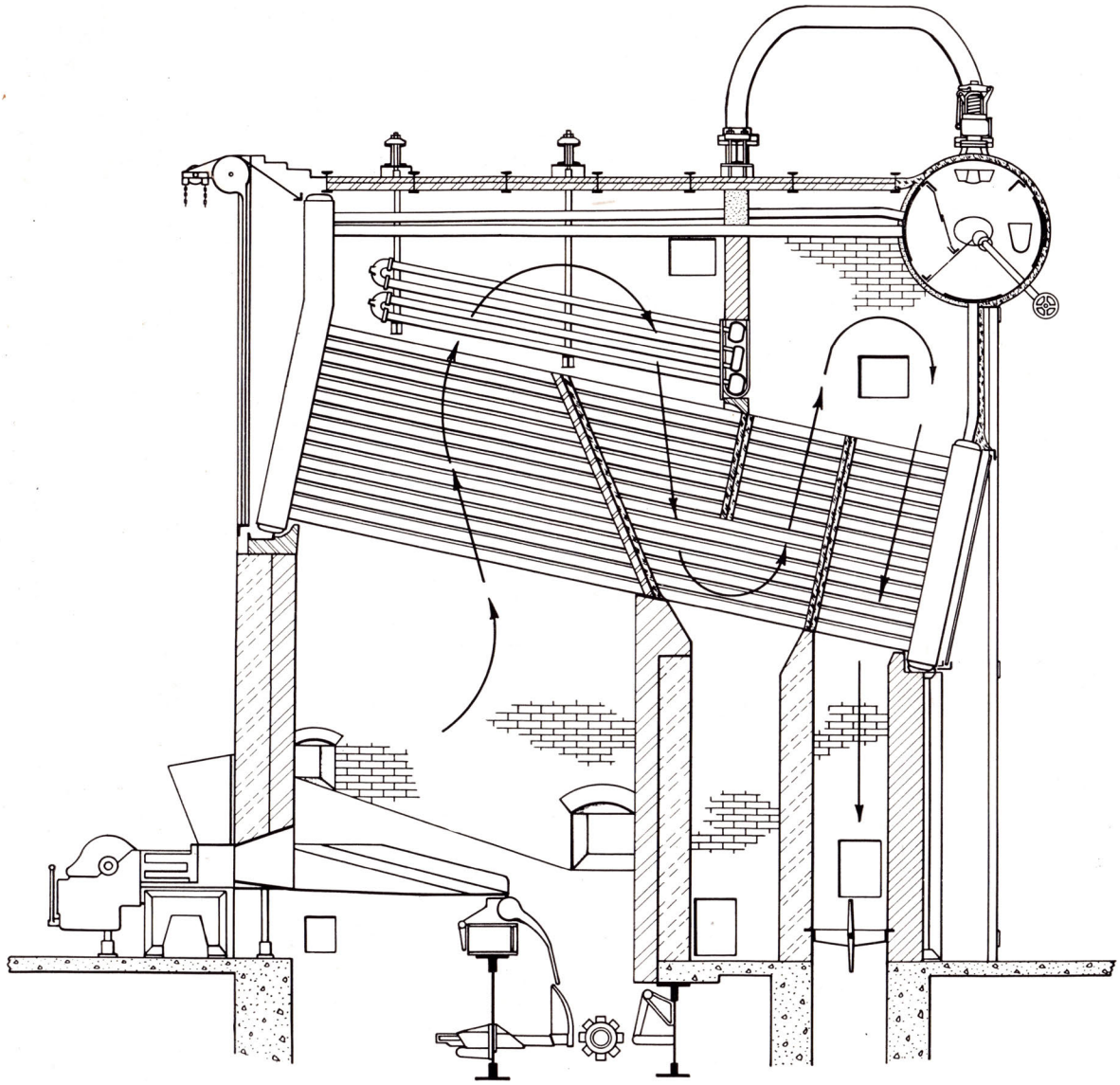
The above plate shows a three-pass cross drum boiler equipped with a forced draft chain grate stoker for burning low grade western bituminous coal. Note how the baffling has been arranged to extend the furnace almost the full depth of the setting and how a few rows of tubes are exposed their full length. Arrangements of this character are desirable where operating conditions require continuous ratings in excess of two hundred per cent.



Cross Drum Boiler—Oil Fired

A feature of this cross drum boiler, installed in a central power plant and fired with oil, is the combined convection and radiant heat superheater. From the convection superheater, located above the main tube bank, the partially superheated steam is carried by the indicated pipes to the radiant heat superheater in the front wall of the furnace above the oil burners. This combination gives a high and even degree of superheat.

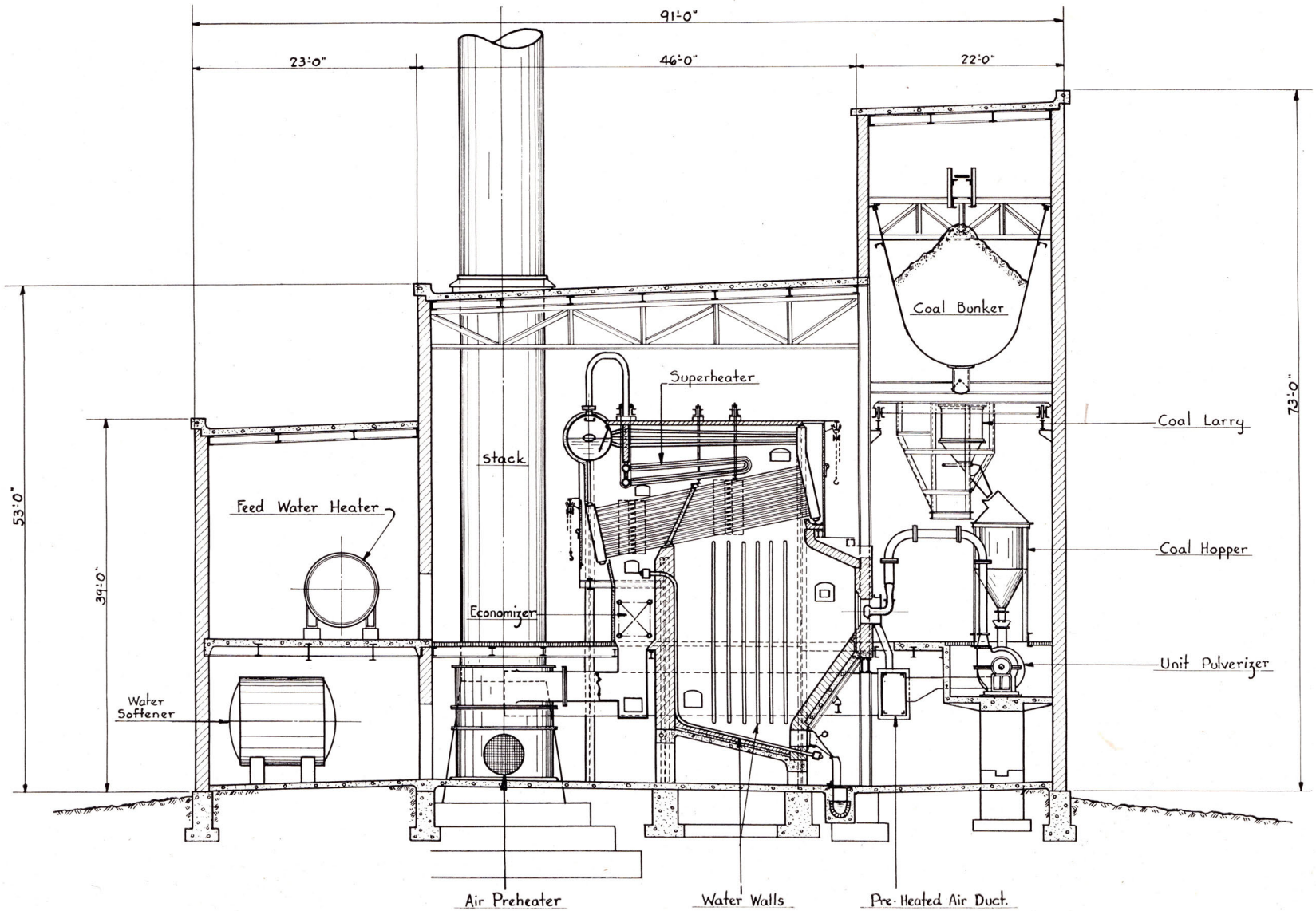
For INCREASED FUEL ECONOMY



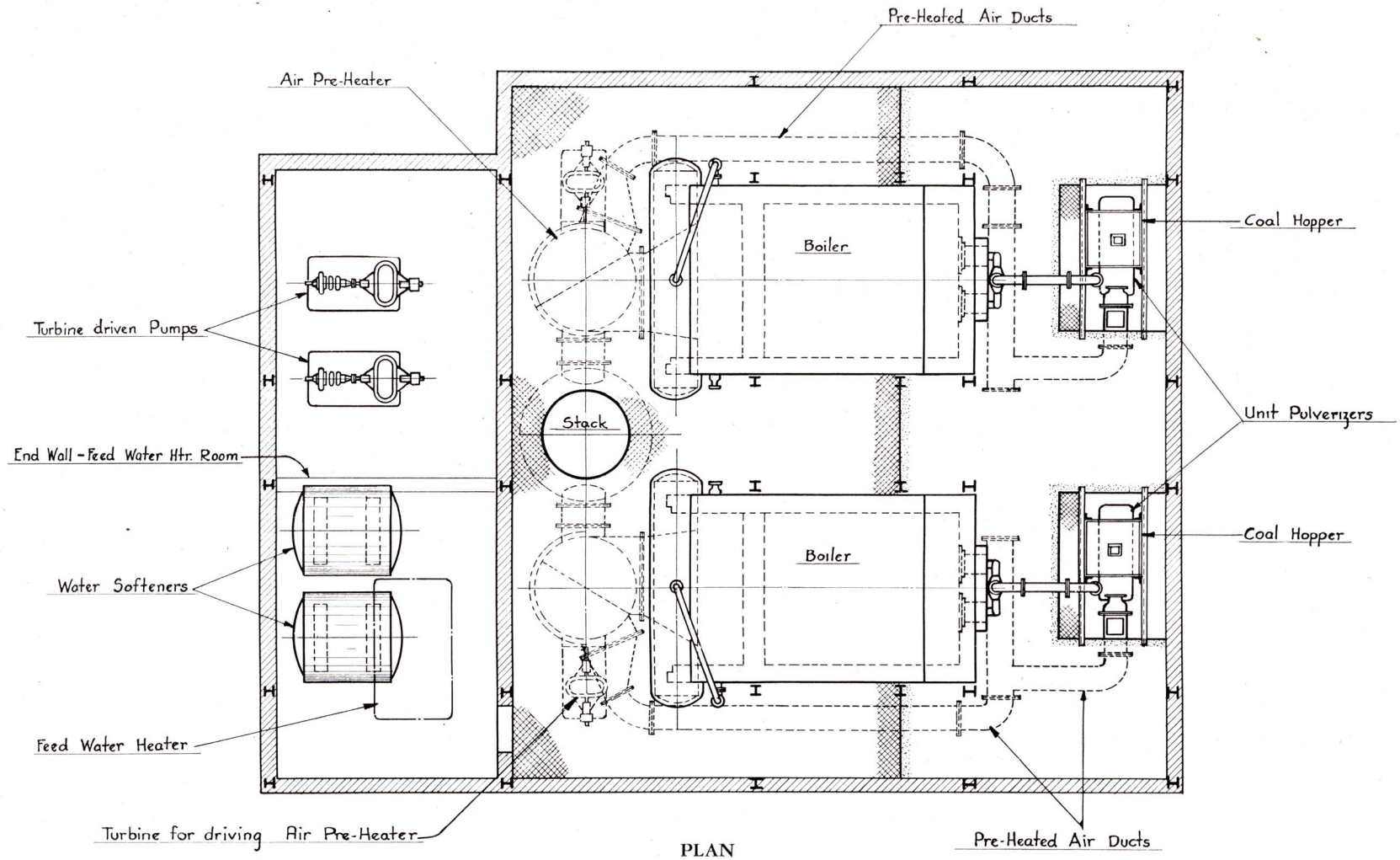
Four-Pass Boiler with Inclined Underfeed Stoker

The cross drum boiler shown above is equipped with a forced draft underfeed stoker known as the inclined type, capable of operating the boiler at high ratings. When so operated, the boiler is set high above the floor to give ample furnace chamber for complete combustion of the coal; the angle of inclination of the first baffle is increased to compensate for the rapid shrinkage of the gases. The baffling of this installation is arranged to pass the gases four times across the tube bank and exhaust them at floor level. By means of the double loop convection superheater, a high degree of superheat is obtained.

General Plan of a Boiler Room



ELEVATION



PLAN

The plan view above and side elevation on the opposite page give the general arrangement of a compact modern boiler house designed for great efficiency at high ratings. The boiler equipment consists of two cross drum boilers arranged for two passes, with the gases led through a small economizer below the second pass to the air preheater and thence to the stack. In front of the boilers are shown the coal bunkers, coal larry, unit pulverizer and pulverized fuel burners. Water walls are indicated in the walls of the boiler setting.

EDGE MOOR *Water Tube* BOILERS

NO matter how well designed and well built a boiler may be, from the very fact that it is continuously subjected to action by such powerful elements as fire, water and air, care must be taken to offset the effect which these elements may have upon the boiler. Many boiler companies have at times published suggestions for the care of their boilers and distributed them to their customers. The Boiler Code Committee of the American Society of Mechanical Engineers has reviewed this subject carefully and published, in a separate pamphlet, Suggested Rules for the Care of Power Boilers as Section VII of the A.S.M.E. Boiler Construction Code.

Since these suggested rules fully cover our recommendations for the care of Edge Moor boilers, and since we believe it helpful to the operator to have such suggestions readily available, we have with the permission of the Boiler Code Committee of the American Society of Mechanical Engineers incorporated certain sections of these suggested rules in this booklet.

For care of boiler fittings and appliances and for general operating instructions, reference should be made to the Suggested Rules for the Care of Power Boilers published by the American Society of Mechanical Engineers. The paragraph numbers shown in the following pages correspond with the paragraph numbers in these suggested rules, and we strongly recommend that operators responsible for the proper care and operation of boiler plants should be provided with a complete copy of these suggested rules, obtainable from the American Society of Mechanical Engineers.

EDGE MOOR IRON COMPANY

For INCREASED FUEL ECONOMY

I. Putting Boilers in Service

Getting Up Steam

C-1. If the boiler is new or has been out of service for an extended period or has been opened for cleaning or repairs, examine the inside of the boiler and make sure that it is free from tools and foreign matter and that there is no one in the boiler; then close manhole openings. In case of a new boiler, boil out for a few hours by the method given in Par. C-42.

C-2. See that the combustion chamber and gas passages are clean and in good repair, and that all clean-out doors in setting fit properly and are closed tight.

C-3. Operate both inlet damper and outlet damper and make sure that they are free and in good condition. Leave the inlet and outlet dampers open. Operate the stoker and draft fan to see that they are ready for service. Make sure that the grates are satisfactory and in place.

C-4. See that the blow-off valves, water column and waterglass drains, gage cocks, and feed valves are in good working condition and closed. Open a vent valve.

C-5. Fill the boiler to such a level that the rise in level due to the steam generation will bring the water level to its normal position when full working pressure and flow of the steam have been reached. Close feed connections. Where auxiliary feed connections are installed, they should be used in filling the boilers as a means of testing their condition. Open and close gage cocks and blow-down valves on water column, and water glass in order to make sure that these connections are free and clear.

C-6. See that the cock to steam pressure gage is open. Examine the safety valves as far as practicable to see that they are in working order.

C-7. Ease up on the stem of the main steam stop valve, slightly lifting the valve off the seat in order to make sure that the valve is not stuck.

C-8. If coal is used as fuel, cover the grate with a thin layer of coal and start a light fire with live coals from adjacent boilers, with wood or other light combustibles. Do not use any combustibles for igniting a coal fire in such a manner as to cause excessive smoke or possible flareback. Where pulverized coal, gas, or oil is used as fuel, make sure that outlet damper is open to create a light draft before introducing and igniting fuel.

C-9. If oil is used as fuel and the system is new or has been out of service for a considerable period, first clean and examine the strainers and remove, clean, and examine tips and burners. If compressed air is available, blow out the oil supply lines with air. Place and adjust burners and tips and work the air registers to see that they are in good working condition. Close individual burner throttle valves. Test the steam coils in the heater for oil leakage by keeping the maximum allowable head of oil on the heater, with the steam pressure shut off. Hold this head of oil on the heater in excess of 15 minutes. Next, unseat the steam valve on the coil with the drip valve wide open. Collect the condensate from the drip and examine for oil.

C-10. Remove any spilled oil about burners, fronts, and floor, and see that there is no oil on the floor of the combustion chamber. Ventilate boiler by opening draft gates and dampers.

C-11. If no steam is available for oil pump and burners, raise steam in boiler by wood fire. Remove any excess accumulation of water in the oil tank. See that oil pumps are warmed up ready for use and that relief valves are properly set. Open suction-line valves and pump oil to burners. If oil lines are equipped with air chambers, charge them with compressed air. Examine oil lines and equipment for leaks.

C-12. Light the center burner by placing a torch near and just under tip of burner; then, turning on the oil, stand well clear to avoid possible flareback. If the torch is snuffed out before the oil is lighted, shut off the oil and relight the torch. Always use the torch for lighting burners until the brickwork is intensely hot, and even then if all burners are out. Next light the adjacent burners, but be sure that there is excess draft before lighting additional burners. Do not allow oil to impinge excessively on the brickwork or parts of boiler.

C-13. After lighting the fire, maintain a light fire until the brickwork of the setting is dried out thoroughly. If the entire setting is new the drying out may require several days; if the lining of the combustion chamber only has been renewed, about 48 hours will be sufficient time for drying out for small settings. Larger ones will require a longer time. After the usual week-end shutdown, a light fire

should be carried for about one hour. Only in extreme emergency should steam be raised in less than one-half hour, even with water-tube boilers.

C-14. After the water becomes heated, check the level of the water in the water glass with gage cocks and examine blow-off valves for leaks. After steam has escaped through the vent valves for a few minutes, close the valves.

C-15. After the brickwork is dried out and the boiler heated begin raising the steam pressure slowly, especially in internally fired boilers where the circulation is sluggish. Keep the water level in sight. When the steam pressure approaches the working pressure and before cutting the boiler into service blow the water down to the proper level, if necessary. Examine the boiler for leaks and test the safety valve or valves by hand, holding the valve or valves open for a short period to blow out possible accumulation of dirt or chips. On high-pressure boilers the safety valves should be popped well before the steam pressure approaches the working pressure.

Cutting In

C-16. Before cutting in a boiler, open and leave open until the boiler is on the line, all drains in the connections between the boiler and the main header, especially the open drains between the two stop valves. In general, in cutting in a boiler to a steam header already in service, the steam line between the boiler and the header is usually warmed up by backfeed through the drip line or by means of the by-pass valve, and the header valve then fully opened to allow the boiler to cut itself in automatically with the non-return valve. In case a non-return valve is not used the boiler stop valve should, of course, be opened slowly when the pressure in the boiler and the steam line are approximately equal.

a. With two hand-operated stop valves, open slowly (to avoid water hammer) to full opening, the stop valve nearer the main header. When the pressure in the boiler is nearly equal to the pressure in the main header, open slowly, to full opening, the stop valve nearer the boiler.

b. With one hand-operated stop valve and one combined stop and check valve, when the hand-operated stop valve is nearer the main header, open it slowly and preferably only a small amount at first. When the pressure of the boiler is still 10 to 50 lb. below the pressure in the header, slowly back off the valve stem of the combined stop and check valve sufficiently from the check to provide full opening of the check valve. In order to insure that the check valve functions properly, always use it automatically for cutting in and cutting out boilers, provided that the main header is filled with steam at full pressure.

c. With one hand-operated stop valve and one automatic non-return check valve, open the hand-operated stop valve slowly when the pressure in the boiler is still 10 to 50 lb. below the pressure in the main header.

d. If steam is being raised on a boiler not connected to a common steam header, in general, it would be more advisable to raise the steam pressure on the whole steam line at the same time, all drips being open.

e. After cutting in a boiler equipped with non-return valves, with two independent outlets, observe the steam pressure in the boiler to make sure that both valves are open. If the non-return valve is a combined stop and check valve, operate the rising stem after the steam pressure in the boiler has reached its working pressure, in order to ascertain whether or not the valve has opened properly.

II. Handling Boilers in Service

Firing

C-17. Aside from the standpoint of economy, maintain the fire as uniformly as possible in order to avoid excessive combustion, undesirable variations in temperature, and possible gas explosions. In the event of flareback or the snapping out of burners, where oil or gas is used as fuel, shut off the fuel supply and thoroughly ventilate the boiler setting before resuming firing.

Cleaning Fires

C-18. Clean the fires when necessary, but preferably at stated periods and when boilers are operating at low rating as at noon time and just before peak loads. Avoid holes in fire and excessive draft while burning out the fire. Clean fires as rapidly as possible to minimize the amount of cold air entering the furnace. Do not fire too heavily immediately after cleaning. Do not pile hot ashes and clinkers

against the boiler front; use care in quenching and remove ashes as soon as possible.

Banking Fires

C-19. When fires are banked and the furnace temperature is reduced, make sure that enough air is carried through the furnace and boiler to prevent the accumulation of combustible gases within the setting.

Water Level

C-20. The most important rule in the safe operation of boilers is to keep water in the boiler and as constantly at the proper level as conditions will permit. Never depend entirely upon automatic alarms or feedwater regulators, no matter how effective or valuable these devices may be.

C-21. The first duty on entering a boiler room is to ascertain whether the communications and valves between the boiler and the water glasses are free and open, especially when starting up in the morning, whether the fires have been banked over-night or not, by blowing down the water columns and water glasses and noting the promptness of the return of the water to the glasses. Try the gage cocks also until sure of the water level. This should be done at the beginning of each shift and preferably before the relieved shift has gone off duty, and more frequently when trouble is experienced with boiler compounds, foaming, priming, and other feedwater troubles that are apt to cause choking of the connections. It should be done also after replacing water glasses.

C-22. Have the water column well lighted and keep the glass clean. Do not allow steam to leak from the water column or its connections as this will cause the water glass to show a false water level. Keep the outlet end of the discharge pipes from the water column, water glasses, and gage cocks open and free from obstructions.

C-23. When the level of the water is not visible in the water glass, try the gage cocks to determine whether the level of the water is above or below the water glass. If the water level is below the water glass, stop the supply of air and fuel, and close the dampers and ashpit doors, unless fully in touch with the entire situation as to boiler-feedwater supply and positively certain that it is safer to continue steaming the boiler than to reduce the steaming rate.

If found advisable not to stop the steaming rate of the boiler, determine the cause of low water and remedy it immediately. If found advisable to stop the supply of fuel and air, do not change the feedwater supply, open the safety valves or change the steam outlet valves, or make any adjustment that will cause a sudden change in the stresses acting on the boiler. In the case of hand fired boilers, do not disturb the fire except to cover it with green coal or wet ashes; where stokers are used, stop the fuel feed, shut off the air supply and open the fire doors. After the fire is banked or out, close the feedwater valves. When the boiler is sufficiently cooled, close the fire doors and cut the boiler off the line. Determine the cause of low water and remedy it before the boiler is again placed in service. Also examine the boiler for the effects of possible overheating.

C-24. When it becomes necessary to maintain an unreasonably high feedwater pressure, examine the feedwater lines for choking due to scale or other causes.

Wet Steam from Foaming and Priming

C-25. If any unusual or serious foaming occurs, close the steam outlet valve long enough to determine the true level of the water in the water glass. If the level of the water in the glass is sufficiently high, blow down some of the water in the boiler and feed in fresh water. Use surface blow-off if installed. Repeat the alternate blowing down and feeding several times, and, if the foaming does not stop, bank the fire and continue the alternate blowing down and feeding. Test safety valve or valves and connections of pressure gage, water column, and water glass for any sticking or choking. Determine positively the cause of foaming and adopt measures to prevent its recurrence, as specified in Pars. C-203 to C-209.

Oil in Boiler

C-26. Watch carefully for any sign of oil in the feedwater heaters, water glasses, and surface blowdowns. If oil is found in the water glass or surface blowdown, shut down the boiler as soon as practicable and clean it thoroughly. If the amount of oil or grease is considerable, boil out the boiler in accordance with Par. C-42.

Feedwater Treatment

C-27. Execute carefully all instructions given for the treatment of feedwater, if necessary, in the particular plant. It is not advisable to experiment with "home-made" treatments or boiler compounds.

Blowing Down

C-28. Except where the amount and frequency of blowing down is determined by chemical analysis, or its equivalent, blow down at least one full opening and closing of the blow-off valve every 24 hours. Blow down the boilers at a period in the day when the steam production is lowest. When boiler is equipped with both blow-off valve and cock or quick-opening valve in the same blow-off connection, always open the cock or quick-opening valve first and the blow-off valve second. In closing, always close the blow-off valve first and the cock or quick-opening valve second. When a large amount of blowing down is necessary, open the cock or quick-opening valve first, until it is half-open and leave in that position until the water is lowered about ½ in. in the water glass. Then open wide all valves until the blowing down is completed. See that the cock or valve shuts tight and remains tight. Repair all leaky blow-off valves or cocks as soon as practicable. Use surface blow-off, if installed, until the undesirable conditions for which it is employed are corrected.

C-29. Where the water glass is not in view of the operator blowing down a boiler, another operator should be stationed where he can see the water glass and signal to the operator blowing down the boiler.

Leaks

C-30. When small leaks occur, locate their source and repair them as soon as the boiler can be removed from service. If a serious leak occurs, such as a leak along the longitudinal seam or near a flange of a drum head, shut down the boiler immediately by gradually reducing the steam pressure and have the boiler examined by an authorized inspector.

In case of tube failure shut off the air supply, keep the outlet damper open, check the fire and shut the boiler stop valve. Maintain the feedwater supply, if possible to do so, without drawing too heavily upon the supply to other boilers. Shut off the feedwater supply when the brickwork has cooled sufficiently to prevent injury to boilers by overheating.

Repairs

C-31. Many casualties have resulted from the practice of repairing boilers, pipe lines and attachments under pressure; such practice should not be permitted except when officially authorized and under the supervision of a competent and responsible person.

Removal of Soot and Ashes

C-32. Keep tubes reasonably free from soot. When a lance or soot blower is used, drain the steam or air supply connections so that the steam or air is practically dry. After the boiler has been cooled, brush or scrape any hardened soot or deposit from the tubes.

C-33. Remove ashes frequently and do not permit the accumulation of any large amount of ashes in the ashpit, boiler flues, or base of chimney. Do not pile ashes against the boiler front and when wetting down ashes, make sure that no water is thrown upon hot castings. To avoid being scalded, stand well back from hot ashes or refuse while spraying water on them. Do not leave ashes banked about blow-off pipes as a protection.

C-34. When ashes are removed by a suction system, see that the explosion door on the storage hopper is maintained free and in condition. Where steam-jet ash conveyors are used, see that all operators are warned against the water which may collect upon the top of the ashes in the hopper and which may flow suddenly from the gate when the ashes are being removed. When necessary to bar through the gate to release clogged opening, the operator should stand sufficiently aside to avoid being burned by the hot ashes or water.

III. Handling Boilers Out of Service

Cutting Out

C-35. Stop the supply of fuel, burn out the fuel in the furnace, and cool the setting and boiler as slowly as is consistent with operating conditions.

After the boiler ceases to require feedwater and the non-return check valve, if any, on the steam outlet has closed, close the feedwater valves and the main steam stop valve. Where both one hand-operated stop valve and one combined stop and check valve are used, screw down the stem of the combined stop and check valve to hold the valve disk on the seat. Where two stop valves are used, open the drain between the stop valves and see that it is clear. When possible, dust off the tubes before the fire has died out.

Emptying

C-36. Allow the setting to cool slowly, particularly if there is much sediment in the boiler. After the setting has been cooled and there is no pressure on the boiler, open the vent to prevent the formation of a vacuum and empty the boiler. When it is not practicable to empty a boiler at atmospheric pressure, blow it down at as low a pressure as is consistent with operating conditions. When the boiler to be emptied is set in a battery of two or more boilers, make sure that the blow-off valves that are opened are on the boiler that is to be emptied. As soon as the boiler is emptied, close the blow-off valves, remove the manhole plates, and, when necessary, the covers of other openings.

Cleaning

C-37. Boiler cleaners when entering the setting must guard against injury and burns from accumulations of flue dust. Poking nozzle of water hose beneath surface of a pile of flue dust may cause dangerous explosion. Do not step into flue dust until it is known to be cooled beneath the surface. Before any person enters the drums or shell of a boiler, make sure that these parts of the boiler have been properly ventilated and that there is no inflammable gas present.

C-38. Before entering the drums or shell of a boiler, see that the blow-off valves, the main stop valve, the feedwater valves, and other valves are closed. Use some reliable method of safeguarding any one entering the shell or drum.

It is recommended that when the blow-off valves of a boiler being cleaned are connected into a common header, the blow-off valves of all other boilers be properly safeguarded against opening into the boiler being cleaned.

When electric extension cords are used for entering a boiler, the cord should not only be well insulated but designed to withstand mechanical injury and maintained in good condition. The lamps should be provided with suitable guards.

C-39. Examine the boiler to determine how often it should be washed.

C-40. Use hose with sufficient water pressure or hand tools, if necessary, to remove scale. Disconnect the blow-off line and run the water to waste, or when practical, provide a screen which can be inserted in the blow-off hole.

See that the water does not come in contact with the brickwork of the combustion chamber, or if this cannot be avoided, see that the brickwork is dried out carefully when firing up.

C-41. After washing the boiler, pass a light inside and see that the cleaning has been thorough and that no tools are left inside.

C-42. Where a new boiler is to be placed into service for the first time, it may be cleaned by boiling out with a mixture of soda ash and caustic soda. Fill the boiler with water to about the middle line of the water glass and add 1 lb. of soda ash and 1 lb. of caustic soda per 1000 lb. of water held within the boiler. Dissolve the chemicals thoroughly before introducing into the water. Close the boiler and start a light fire, sufficient to carry 5 lb. pressure in the boiler. Continue boiling two or three days. Then empty the boiler and wash it thoroughly with fresh water.

Laying up

C-44. When laying up a boiler for an extended period of time, follow the instructions given in Pars. C-244 to C-248.

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